Design and performance analysis of Grid Connected Transformerless Photovoltaic Power system

SYNOPSIS

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Introduction:

Every country relies on energy for economic and social progress. Due to fossil-fuel scarcity and nuclear-fuel shortages, modern life faces serious energy demands every day. For electricity generation, fossil fuels are still very important despite being highly polluting, Carbon dioxide in the air accumulates as a result of air pollution, causing acid rain and smog. Aside from being complex and expensive, nuclear energy also poses a high level of safety concerns considering the fuel it uses and the increased safety precautions it requires. Aside from being a primary cause of environmental pollution, as well as being a primary cause of human death, nuclear fuels are also an environmental threat.

Renewable energy is the only source that can solve the environmental related problems produced by nuclear power and fossil fuels. Renewable-energy-sources, are the only source that can replace fossil fuels and nuclear fuels on a global scale. In addition to being environmentally friendly, renewable resources are also economically advantageous. Solar, wind, biomass, hydropower, wave power, and tide energy are examples of renewable energy sources. In recent years, photovoltaic technology, or solar energy, has become one of the most popular sources of renewable energy. Thus, photovoltaic inverters are becoming increasingly popular among scientists. There are a variety of applications that use grid-connected transformerless inverters, the energy efficiency of which is high and leakage current is low. Transformer-less inverters connected to PV

grids have better efficiency, cost-effectiveness, and size than transformer-based inverters. Because grid-connected transformer-less PV inverters cause high currents to ground when charging and discharging, in order to maintain their common-mode voltage (CM), it is crucial to keep them constant.

Losses are higher, safety is compromised, and electromagnetic interference (EMI) occurs due to this CM ground current or leakage current. Photovoltaic systems connected to the grid produce energy based on the efficiency and reliability of their inverters.

Owing to the huge potential and environment-friendliness of the solar energy, solar photovoltaic system is being installed in increasingly large capacities and it is expected to be largely employed to meet the increasing future demands. The power converted can be most efficiently used when the system is grid-connected. To be able to meet energy demands effectively, the technical issues occurring in a grid-connected system must be mitigated. A PV panel with parasitic capacitance has the problem of leaking current. Currents of this type are called common-mode currents or ground currents.

Transformer-less PV inverters' with full-bridge operation (H4) mainly use unipolar, bipolar, or hybrid modulation techniques. In unipolar operation there are no losses at zero voltage states, resulting in low core loss and high efficiency. To reduce leakage currents and improve efficiency, transformerless PV inverters have been developed using unipolar PWM control. By using H4 inverters with bipolar SPWM technology, leakage current problems can be solved, while magnetic induction losses and switching losses make these inverters inefficient,.

In the H5 inverter topologies, unipolar SPMW has been used to solve the leakage-current problem. A H5 topology has high conduction losses despite being connected in series with three active switches.

HERIC transformerless inverter topology has been analyzed using MATLAB/Simulation to reduce leakage current. The current path contains only two switches, the HERIC transformerless inverter eliminates high losses.

Transformerless inverter circuits should be designed to minimize leakage currents, a detailed analysis of H6 inverters is performed. In order to achieve the H6 inverter topology, an inverter switch has. A H6 inverter-circuit reduces conduction losses and improves inverter efficiency. By maintaining a constant

common mode voltage, the H6 inverter will have less leakage-current. Despite the fact that there are six switches in the circuit, in simulations, it has been found that the H6 inverter performed better than conventional H4, H5 and HERIC inverters in suppressing the leakage current. Because the additional switch provides a DC path compared to H4 and H5, it reduces losses. Therefore, the designed H6 inverter is a promising topology as it reduces losses, eliminates leakage current and increases inverter efficiency.

An inverter topology has been proposed by modifying the conventional H-bridge to diminish the leakage-current occurring in a grid-connected-transformerless-PV-system. The common mode current, if not suppressed, not only causes maloperation of protective system thus posing safety hazards but also causes electromagnetic interference, slow deterioration of PV panel and introduces harmonics into the supply. The method adopted in proposed topology is the decoupling of ac and dc sides along with clamping of one of the bridge leg voltages to midpoint of dc link voltage. Both methods are activated in the freewheeling/zero state of the H-bridge through two additional switches and a diode. The variation of common mode voltage is thus checked leading to reduction in common mode current while other performance parameters like efficiency, total harmonic distortion (THD) are not much affected.

Objective of the thesis

- Design of different modulation scheme for transformerless H-bridge PV inverters.
- Design of the conventional PV transformers inverter topology for grid-connected PV system.
- Design of the proposed PV inverter topology for a grid-connected transformers PV system.

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